Software Design GAENet Improve Accuracy of Tone and Performance of Workers in the Manufacturing Process Balinese Gamelan

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Abstract: Gamelan or traditional orchestra is still produced manually and the traditional way. The most important step in making Balinese gamelan namely *ngelaras*. *Ngelaras* means the process of obtaining accuracy in accordance with the tone of the reference tone.. Tunings process is still based on the sensitivity of the ear and the feelings of the gamelan craftsmen so that the precision of tone cannot be achieved. The unavailable of a standard measuring instruments tone used in the tuning process lead to the production process gamelan in Bali takes a long time. To solve these problems, a study conducted by utilizing information technology in the computer - software engineering with ergonomics approach. The software is intended will be able to perform the test tone as desired by the buyer. Thus the tone of the achievements obtained quickly, accurately correspond to the reference tone. Furthermore, the production expectations of Balinese *gamelan* craftsmen more competitive and sustainable. It also means that the program contributed significantly to the preservation of Balinese culture can be done.

Keywords: GAENet, Software, Toning acquisation, Human tester, Measuring instruments, Ergonomics

I. INTRODUCTION

Background

Until today the Balinese gamelan is only made in Bali and the process is categorized as home industry. The Balinese gamelan is made of filigree material which is a mixture of lead and copper through metal melting process and then it shaped in a mold. The process of gamelan making in Bali is still done traditionally, whether the process of material processing or the equipment use is still manual and traditional, including the method of tone test is still depend on the sensitiveness of the tester's ears, so the work is done repeatedly.

Pager (2009) stated that to produce a set of Balinese gamelan needs approximately 10 months. This is because the process of the making or the equipment use is still traditional and beside the limitation of human resources in the tester field to determine the adjustment of basic tone of gamelan. Thus means the adjustment measurement tool of gamelan tone which is required is very important to prepare.

The un-natural working posture like Picture 1 will cause to raise various disorders on the musculoskeletal system (Manuaba, 1990). The sitting position in long time with un-natural working posture or bending cause disorder on the musculoskeletal system and there is a quite much pressure on the discus intervertebralis so it can cause low back pain. This working posture in long term will cause body to bend (kiposis) (Pheasant, 1991; Grandjean, 1988).

Figure 1. The conventional tone assessment

From the description above it can be stated that the biggest problem happen on the adjustment process, so this process meds to have priority to be solved first. Alternative way to solve the problem on this process is by using aid tool so the adjustment that is done manually and repeatedly will no longer happen. In Figure 2 the assessment performed by the software, so that the more measured tones. The Gamelan Arrangement Evaluation using Artificial Neural Network (GAENet) Software is made as the measuring tool to get more measurable basic tone standard. Adiputra, et al. (2001) stated that through ergonomic intervention on the small industries by using ergonomic chair and table will decrease working load and subjective complaint, and also increase working productivity significantly. As ergonomic implementation on the small industries, it is also done the betterment of work station in this research so the working posture of the tester is become more natural.

Figure 2. Assessment of the tone by using the GAENet software

Purpose and Use of the Research

The general purpose of this research is to find out the improvement of Balinese gamelan tone tester performance after the implementation of GAENet software. The use of this research is that this GAENet software can be used as the aid tool in the assessment of Balinese gamelan tone tester which is more measurable.

Research Hypothesis

Implementation of GAENet software increase assessment accuracy, accelerates assessment time, and increase satisfaction of Balinese gamelan tester assessor.

II. RESEARCH METHOD

The research is the experimental research by using the same subject design (*treatment by subject design*). Sample collection technique conducted by simple random sampling, that is everyone who fulfilled the inclusion criteria has the same opportunity to be selected as a sample in this research. The size of the sample is determined by using the Lemeshon's formula (1985) with $\alpha = 0.05$ and $\beta = 0.1$. The outcome is obtained that the amount of samples are 15 persons, who are selected simply randomly with toss-up technique.

The research variables are identified and classified as follows: (a) independent variable is the GAENet software and ergonomic workstation; (b) dependent variable is the aligner's performance who is assessed by the accuracy, productivity, satisfaction, weariness, and musculoskeletal complaint; and (c) controlled variables which consist of: aligner's internal factors (age, gender, health), and external factors (wet temperature, dry temperature, relative humidity, wind velocity, noise, and light intensity).

The data analysis conducted by the way as follows: (a) descriptive analysis; (b) normality test by using Shapiro-Wilk test; (c) microclimate data, work pulses, accuracy, productivity, satisfaction, weariness after work, and musculoskeletal complaint, were analyzed using t-paired test and data of the rest pulses and weariness prior to work was tested with Wilcoxon test in the real level (α) = 0.05. Data is processed using SPSS for Windows version 16.0 program.

III. RESULT AND DISCUSSON

A. GAENet Software Design

The result of GAENet software reliability test, involving 30 competent respondents in the field of program application found out that 66.7% of respondents said that GAENet device had a complete feature and 33.3% said that it had very complete feature; 73.3% said that GAENet was reliable and 26.6% said that it was very reliable; 33.3% said it was easy to use and 66.7% said it was very easy to use; 73.3% said it was safe and 26.7% said it was very safe; and 13.3% said it could document well and 86.7% said the documenting was very well.

GAENet program is the program used to match the *gamelan*'s instrument tone used as the tested tone with gamelan's instrument tone that used as the basic reference. The program consists of several functions packed in several modules to get the matching outcome.

Following is the running out of the GAENet software that shows the features of this software and analysis result of the software. Tones which are used as the reference in measurement are stored in the reference tones database. By choosing one of the reference tones then it will display the visualization and characteristic of the frequency. Furthermore, the tester can do the measurement of desired tones according with the reference tones in real time as shown in Figure 5.

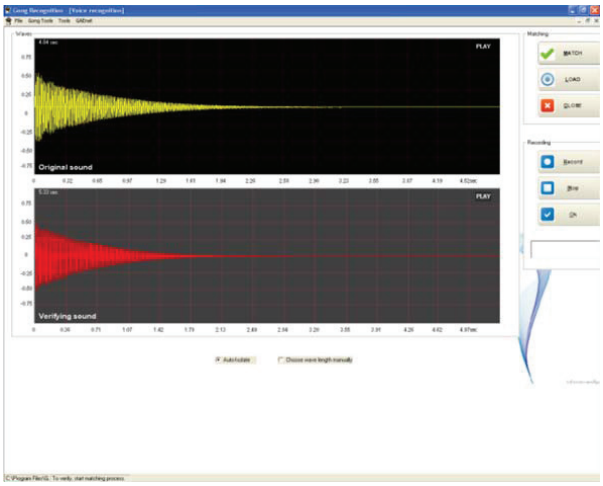

Figure 5. Frequency measurement graphic of reference tones with the tested tones.

The Figure 5. shows the real time result of tune measurement. By the existence of this software the testers are no longer using the sensitiveness of their ears in determining basic tones of the gamelan laths. With this software the tester can obtain basic tones faster, more accurate and more measurable.

The Figure 6 below shows the accuracy of point-to-point frequency which is measured by the reference tones frequency. This picture also shows the measurement value of tune frequency 98% match to the reference tune frequency. If the gamelan tester can determine the tones accurately then in the measurement process the software will analyzed the percentage of accuracy between reference tones with the tones to be matched.

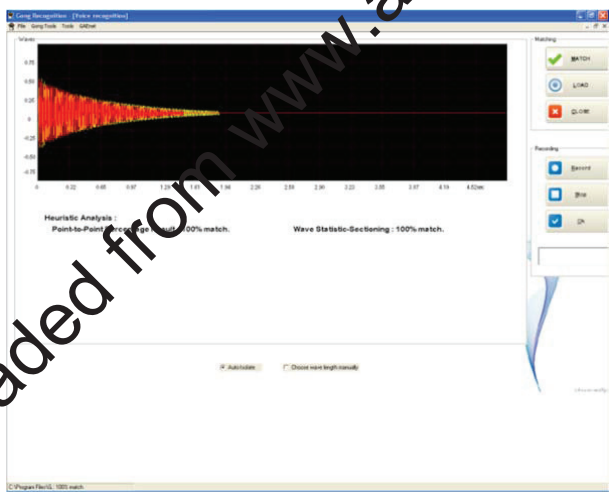

Figure 6. Graphic of matching result of reference tones frequency measurement with the tested tones.

B. Speed

Analysis of treatment effect is tested based on the mean working speed between groups after treatment is given. Significance analysis result with t-paired test is served in Table 1 as follow.

Table 1. Mean Speed between Groups after Treatment is given

Subject Group	n	Mean Speed	SB	t	p
Control	15	17.60	1.35		
				19.724	0.001
Treatment	15	11.93	0.96		

Table 1 above shows that the working speed of control group is 17.60+1.35 and mean of treatment group is 11.93+0.96. Significance analysis by t-paired test shows that the t value = 19.724 and p value = 0.001. This means that both groups after treatment is given, the mean of their working speed is significantly different ($p < 0.05$).

The speed of gamelan's adjuster assessment, which is the time target of tone adjusting which is able to be finished in a shorter period of time than the time needed before. Based on this research result it is obtained that working speed of control group is 17.60+1.35 and mean of treatment group is 11.93+0.96. Significance analysis by t-paired test shows that both groups after treatment is given, the mean of their working speed is significantly different ($p < 0.05$). This is due to software as an aid instrument in gamelan adjusting is capable to give measured tones information in a shorter time from the time needed before. The use of GAENet software can increase speed for 32.22% due to the adjuster is not worried again to grind the lath parts that he is adjusting, so the expectation of the grind can be done appropriately and fast.

C. Accuracy Level

Treatment effect analysis is tested based on the mean of accuracy level between groups after treatment is given. Significance analysis result by t-paired test is served in Table 2. as follow.

Table 2, Mean of Accuracy Level between Groups after Treatment is given

Subject Group	n	Mean of Accuracy Level	SB	t	p
Control	15	94.60	0.83		
				11.613	0.001
Treatment	15	97.93	0.96		

Table 2 above shows that the mean of accuracy level of control group is 94.60+0.83 and mean of treatment group is 97.93+0.96. Significance analysis by t-paired test shows that the t value = 11.613 and p value = 0.001. This means that both groups after treatment is given, the mean of their tone accuracy level is significantly different ($p < 0.05$).

The assessment accuracy of gamelan's tone adjuster is the result closeness level which is achieved to the assessed tones or which the quality is being calculated. Thus the output from the adjuster is according to the desired validity level. Based on this research result it is obtained that the mean of accuracy level of control group is 94.60+0.83 and mean of treatment group is 97.93+0.96. Significance analysis with t-paired test shows that both group after treatment is given, the mean of tones accuracy level is significantly different ($p < 0.05$). The increasing of the accuracy level for 4.26% after using GAENet software and ergonomic working station is because in the adjusting process the frequency of the reference tone *(petuding)* has been known, so it can be easily to bring closer the lath's frequency which is adjusted with the reference tone frequency. In addition, with the assistance from GAENet software it is more confident in grinding the adjusting laths, so they can really be closed to their reference tones. The impossibility of accuracy level to 100% is more because of the different lath's material whether it is the solidity or the material's composition.

D. Satisfaction

Treatment effect analysis is tested based on the mean satisfaction between groups after treatment is given. Significance analysis result by t-paired test is served in Table 3 as follow.

Table 3, Mean Satisfaction between Groups after Treatment is given

Subject Group	n	Mean Satisfaction	SB	t	p
Control	15	16.87	1.06	16.301	0.001
Treatment	15	23.40	0.91		

Table 3 above shows that mean satisfaction of control group is 16.87+1.06 and mean of treatment group is 23.40+0.91. Significance analysis with t-paired test shows that t value = [illegible] and p value = 0.001. This means that both groups, after treatment is given, have significantly different mean satisfaction ($p < 0.05$).

Satisfaction of gamelan adjuster assessment is a feeling of pleasure or not of a result of what he is doing at that time. A person's attitude to the assessed result, high satisfaction level will have positive attitude to his assessment. Based on this research result it is obtained that mean satisfaction of control group is 16.87+1.06 and mean of treatment group is 23.40+0.91. Significance analysis with t-paired test shows that both group after treatment is given, mean satisfaction is significantly different ($p < 0.05$). The increasing of satisfaction score for 27.91% is because of time needed is shorter from the working time before, accuracy level also increases, so does the working effectiveness also increase satisfaction to the adjuster. Basically, assessment satisfaction is an individualistic. But in this case software is established based on the rules or criteria on Balinese gamelan tones. Satisfaction level to the assessment of a gamelan adjuster is no longer individualistic but it is already in the reference framework in pitch *(Ngumbang-ngelog)* of gamelan tones. This research is supported by Istiningsih and Wijanto's research result (2011) which stated that there is a quality effect of information system to the satisfaction of accounting software final user significantly. It is different with Wijayanti's research result (2011) which stated that organization commitment, organization commitment, interaction and motivation, and professional commitment interaction and motivation in apart or together have no significant effect with working satisfaction at *Kantor Yayasan Pendidikan Internal Audit Jakarta* (the Office of Internal Audit Education Foundation Jakarta). Satisfaction also has impact on the adjuster's diligence in doing his activity. Adjuster with high level of satisfaction tends to work in high spirit. Working quality and result that can be achieved by someone who satisfies with his working result will also cause satisfaction to the product's user, in this case the Balinese gamelan instrument. Working satisfaction is a desire of every people. Someone who satisfies will make him in a better health than a person who disappointed (Parasurama et al., 1988). Satisfaction also related to the existence of feeling secure and

comfortable. When someone satisfies he will feel more comfortable and his safety is not disturbed. Adjuster's feeling of satisfaction is related to the availability of physical facility to help his adjusting activity, instrument's reliability and instrument's benefit. This opinion is in line with Titin's research (2010) which reported that ergonomic intervention in the stamping part body component process in stamping plant division of PT. ADM Jakarta increase the employee's working satisfaction for 8.83%

E. Working Productivity

Treatment effect analysis is tested based on mean of working productivity between groups after treatment is given. Significance analysis result with t-paired test is served in Table 4 as follow.

Table 4. Mean of Working Satisfaction between Groups after Treatment is given

Subject Group	n	Mean Heart Rate	SB	t	p
Control	15	0.382	0.034	11.190	0.001
Treatment	15	0.543	0.052		

Table 4 above shows that mean of working satisfaction of control group is 0.382+0.034 and mean of treatment group is 0.543+0.052. Significance analysis with t-paired test shows that t value = 11.190 and p value = 0.001. This means that both groups after treatment is given, their mean productivity is significantly different ($p < 0.05$).

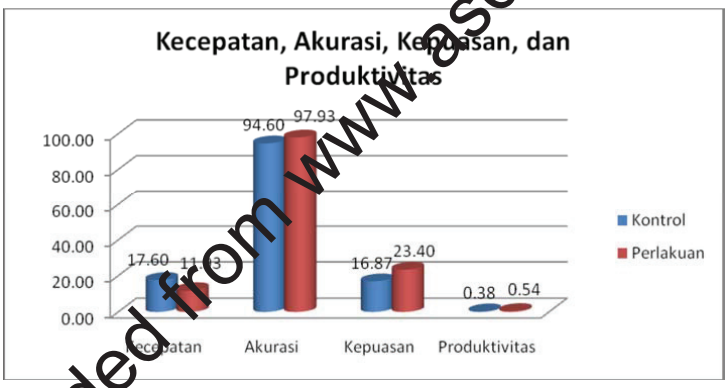

Figure 7. Comparison of Working Speed, Accuracy Level, Satisfaction, and Working Productivity between Control and Treatment

Basically productivity is a final result from all activity components. In this research productivity is calculated based on lath numbers that can be adjusted in one working hour which is divided by working pulse multiplied by 1 working hour. Based on this research result it is obtained that mean of working productivity of control group is 0.382+0.034 and mean of treatment group is 0.543+0.052. Significance analysis with t-paired test shows that both group after treatment is given, mean productivity is significantly different ($p < 0.05$). Furthermore, it is obtained that there is an increasing of productivity for 29.63%. The increasing of worker's productivity and compressing high cost is one of advance steps to win global competition.

Such as empowering human resources and compressing all costs but increasing optimal production output. By compressing cost as small as possible such as expense that has to be paid for paying health allowance and illness rehabilitation as result of working, accident, and injury. This can be done by developing working condition and working surroundings that is healthy, safe, and comfortable. In other word, by implementing working effectiveness such as choosing and shifting to technology that is really effective. In addition, it also can efficient the capability, skill, and human resources constraints by giving equipment's, harmonious working surroundings and method, and other efforts by increasing physical health, knowledge and skill. Technology development is one of factors that determine working productivity because it will make easier workers in making appropriate goods or service. The using of ergonomic equipment's can also increase productivity in other fields. This research result is in line with Suputra's research result (2003) which stated that the using of working seat and table which is appropriate to worker's anthropometry is able to increase working productivity for 16.87% ($p < 0.05$) on Palimanan stone roster sculpture at Mahkota Bali Company. And also does Nuada's research (2005) which also stated that the improvement of seat dimensions and working field height which is appropriate to concrete brick maker's anthropometry is able to increase working productivity of the concrete brick maker for 167.25%.

IV. CONCLUSION AND SUGGESTION

A. Conclusion:

Based on the results and discussion above, it can be concluded as follows:

1. GAENet software design improved performance through increased speed of aligning assessments of 32.22% Balinese gamelan caused an erosion shaved of expectations can be precisely and quickly done.

2. GAENet software design improved performance through increased accuracy of aligning assessment of 4.26% gamelan Bali because in the process of alignment of the reference tone (petuding) has been known to frequent, with the help of tools GAENet more convincing in the shaved blades so it's really near to frequency of reference tone approaches.

3. GAENet software design improved performance through increased satisfaction of Balinese gamelan aligning appraiser 27.91% due to the time it takes shorter time than previous work, the accuracy also increases, so does the effectiveness of the work is also increasing satisfaction for the aligning.

B. Suggestion

1. Researchers gave suggestions to overcome the problem setting the tone in the musical instrument known as gamelan *ngelaras* (tuning tones), has no fixed and definite standards, are expected to use software that can determine GAENet tone gamelan measurable standards. By using the standard tone was measured by aligning gamelan performance quickly find a tone needed and a human role in GAENet only as assessment evaluators.

2. With the results of this study, suggested the existence of standardized tone system, especially the tunings of *gamelan gong gede*.:

V. ACKNOWLEDGMENT

A great appreciation goes to promoter, co-promoter and everybody who has made valuable contributions in this study and their critical comments on this manuscript.

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